

LS (or P) Tube Detector Concept

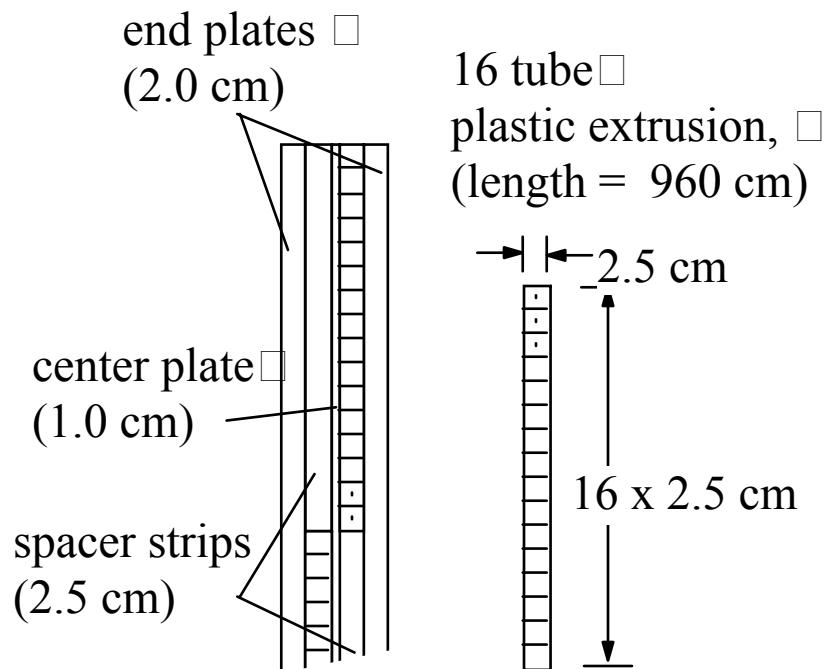
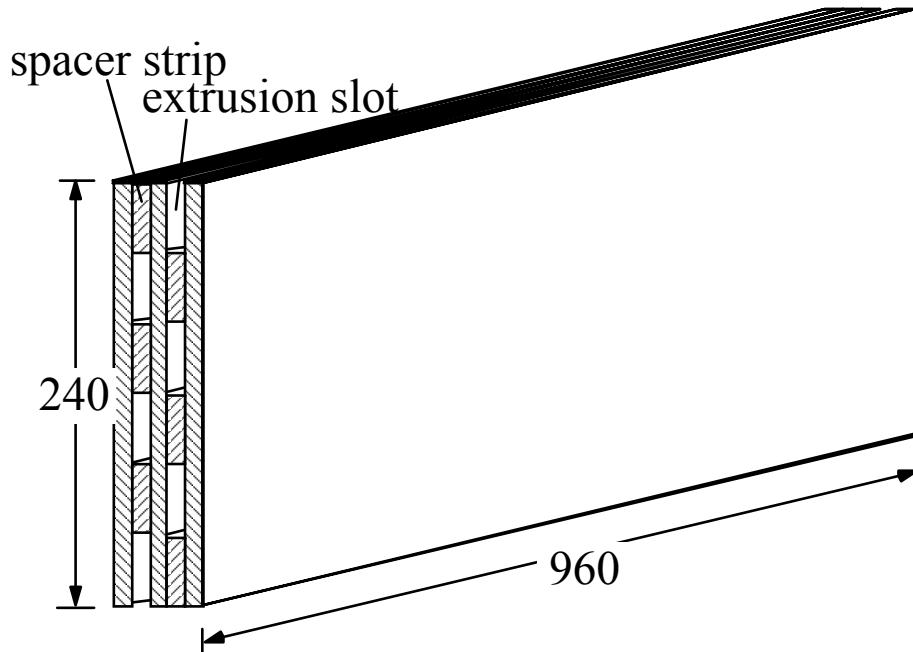
- Outline
 - ↗ Why gas filled tubes?
 - ↗ Extruded tube and absorber integration
 - ↗ Cost estimate
 - ↗ Building integration
- Why gas filled tubes?
 - ↗ Robust; large body of experience
 - ↗ Efficiency and live fiducial area nearly 100%
 - ↗ Critical connections (gas, HV, readout) easily accessed
 - ↗ Geometry compatible with monolithic absorber
 - ↗ Costs significantly reduced vs. typical tube detectors
 - Hodoscopic measurements
 - Absorber can provide strength
 - Robotic construction feasible
 - 2D readout?

Cost reduction of LS(or P)T construction

- Significant cost reductions vs. typical tube detector.
 - ↗ Hodoscopic only!
 - Wire location tolerance, $\sigma \sim 300$ microns
 - Unsaturated drift- v is OK
 - Slow (perhaps safe) gases are OK
 - Tolerances consistent with semi-automatic or robotic wiring
 - ↗ Mechanical issues
 - Strength provided by absorber
 - Plastic extrusion, *full* tubes, carbon loaded
 - Alignment ~ 0.5 cm, easily achieved with absorber
 - ↗ Readout configurations can be optimized
 - 1D, 2 x 1D, or 2D
 - Readout can use wires, strips, or both

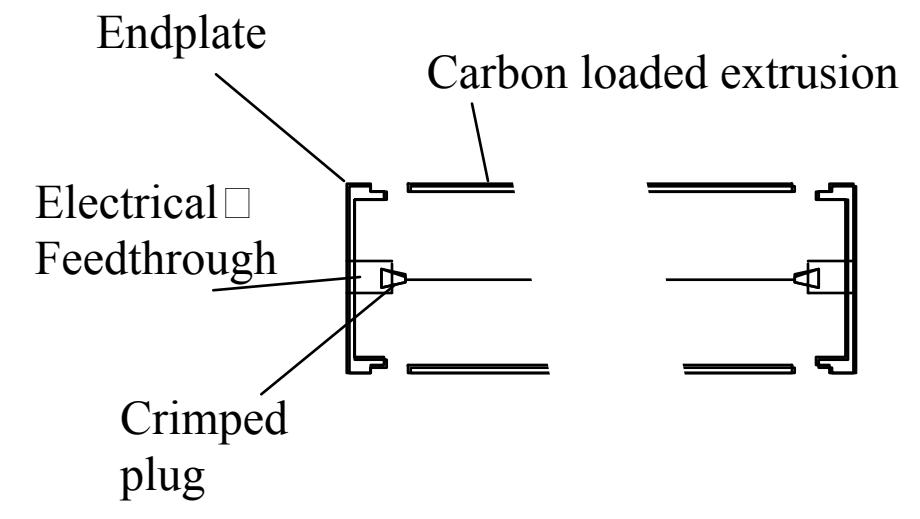
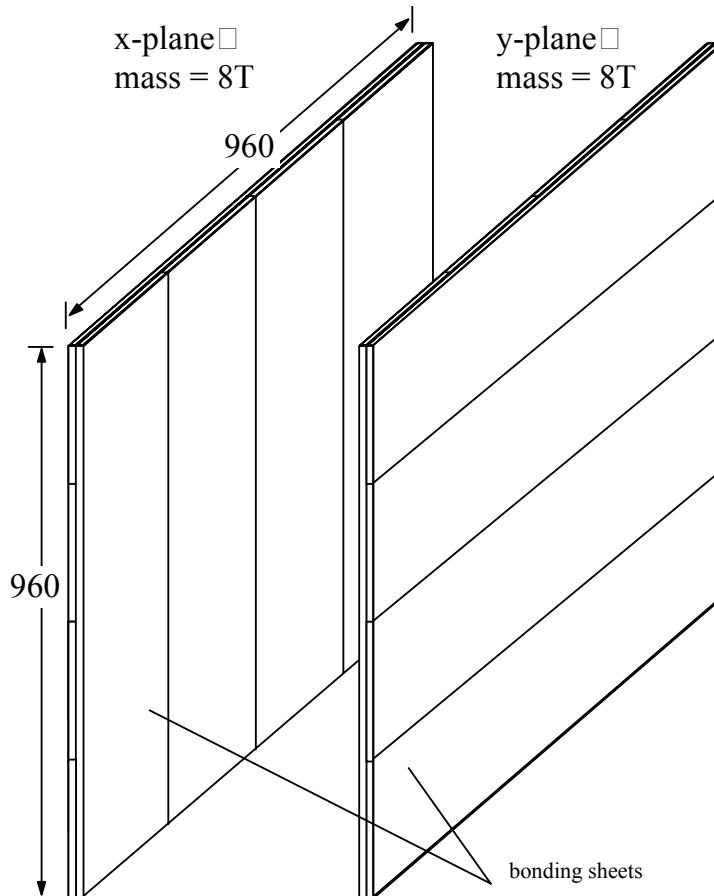
2 x 1D gas tube detector

- Monolithic absorber (\$300/T) concept
 - ↗ Particleboard lamination (w/dowels)
 - ↗ Spacer strips alternate with slots for extrusions
- Spacer thickness to match extrusion
 - ↗ Thin center plate (1 cm)
 - ↗ Spacer strips match square (2.5 cm) or rectangular tube dimension
 - ↗ End plates (2.0 cm)

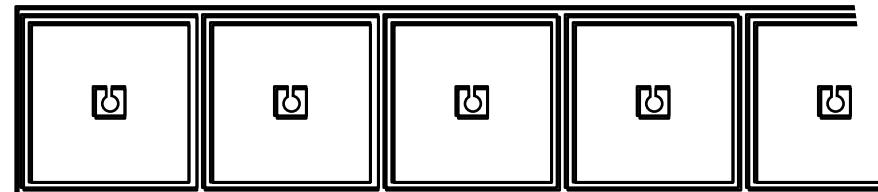


2 x 1D gas tube detector

- Overlap 4 solid and 4 slotted absorbers
- Mass 8T 10 m x 10 m
- Solder-less wiring of extrusion
- Wire tension held by crimped on plugs

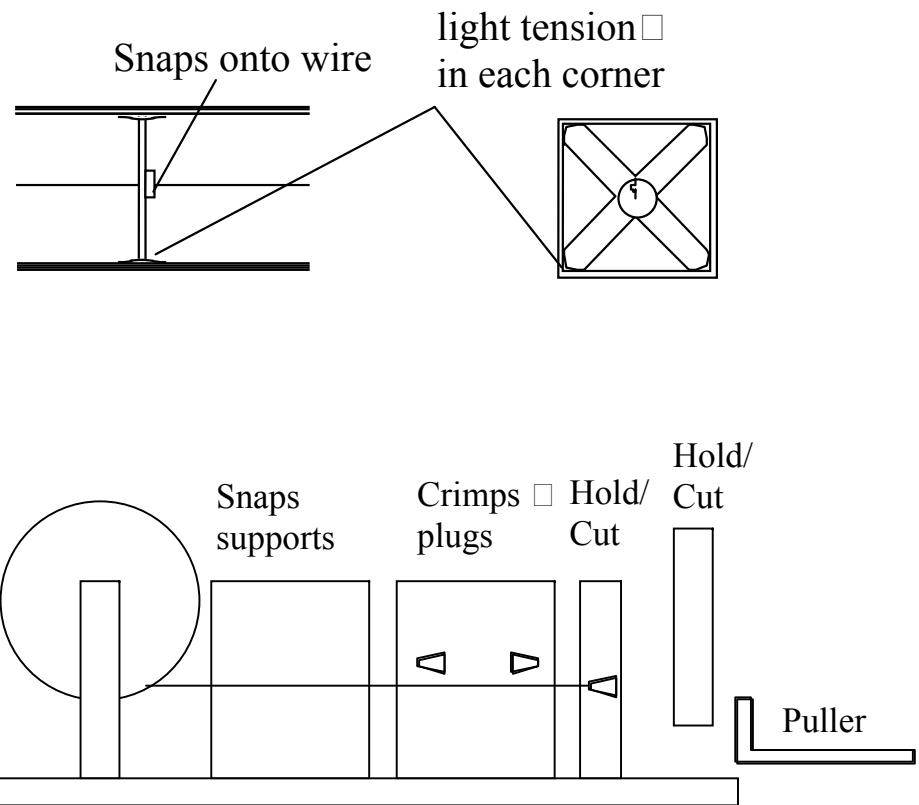


- Injected molded endplate w/feed-through



Wiring Techniques

- Injection molded wire supports
 - ↗ Snapped on wire
 - ↗ Pulled through tube with wire
- Semi-automatic or full robotic wiring
 - ↗ Mount spools with feed control
 - ↗ Crimp plugs onto wire
 - ↗ Snap supports onto wires
 - ↗ Pull wires through tubes
 - ↗ Apply tension and insert plugs into endplate feed-through

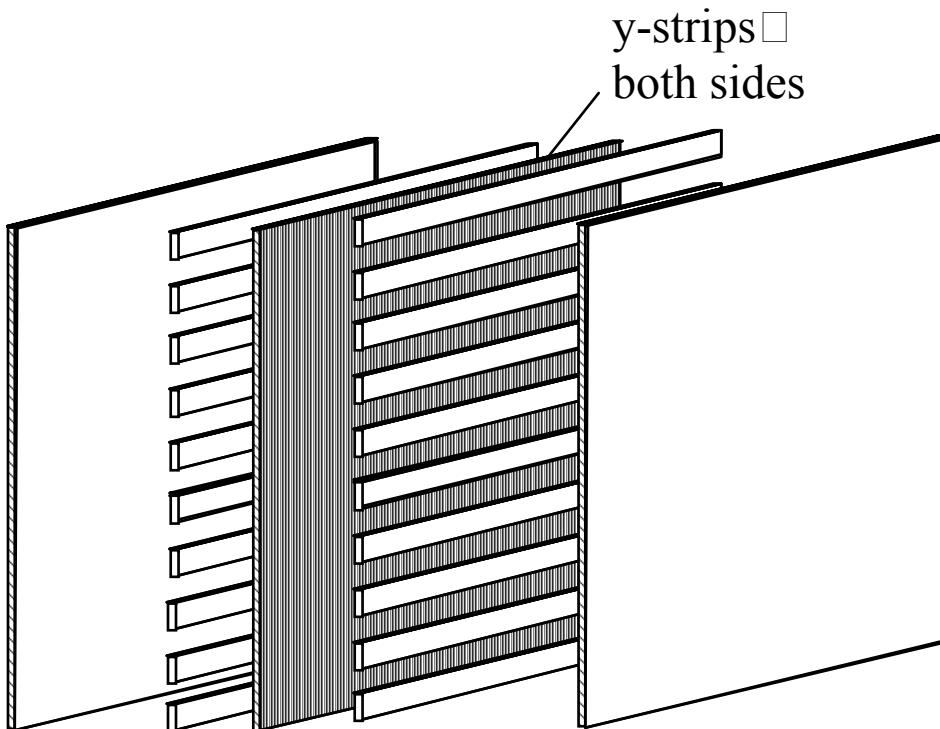


2 x 1D readout costs

● Detector parameters		● Materials cost	\$10.0M
↗ 300 x-y pairs (600 total planes)			
↗ Wire length, 9.6×10^6 m		● Assembly	
↗ 1D area, 2.4×10^5 m ²		↗ 500 days, 480 m ² per day	
↗ Channels (20 m), 4.8×10^5		↗ 120 units (4 m ²) per day	
● Materials	<u>Cost(\$)/m²</u>	↗ Wiring robot, 2 units/hr.	
↗ Plastic (carbon) extrusion	20.0	↗ Need 60 robot-hr. per day	
↗ GPTW (Luma \$0.12/m)	4.8		
↗ I-mold endplate (2 per 4m ²)	5.0	● Labor	<u>Cost (\$M)</u>
↗ I-mold supports (1 per 2m)	2.5	↗ 8 robots (2 robots at 4 sites)	2.0
↗ Gas fittings, HV connectors	5.0	↗ 2 people/robot @ \$40/ hr	2.4
↗ Aluminized exterior (\$1/m ²)	2.0	↗ Misc. labor	<u>0.6</u>
↗ Electronics interface	<u>2.5</u>		Total Labor cost <u>5.0</u>
	Total		
	41.8	● Total cost	\$15.0M
		● Effective cost	\$62.5/m ²

2D readout (x-tubes & y-strips)

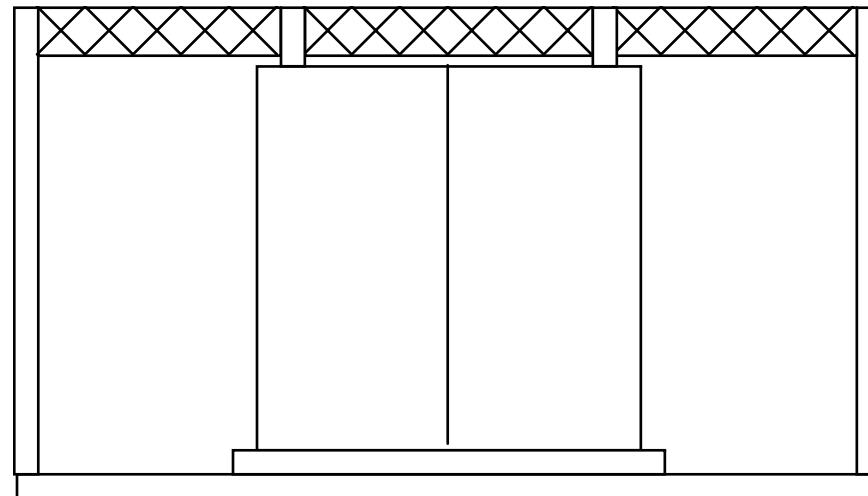
- Replace vertical tubes with y-strips
 - ↗ Number of tubes halved, and strip do not add much to total cost
 - ↗ Sampling doubled, $\sigma(E)$ suffers
 - ↗ Monolithic construction retained



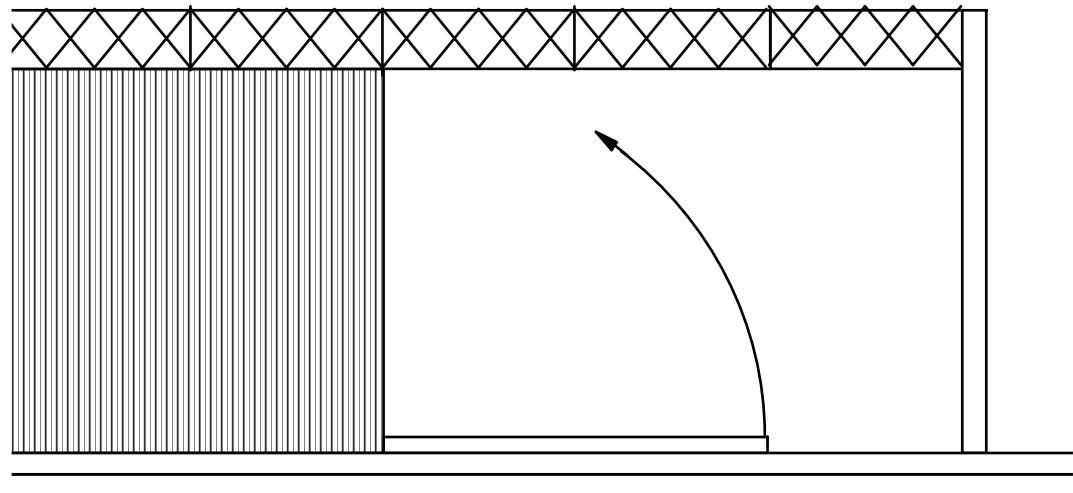
- Y-strips
 - ↗ Metal foil-on-paper, glued on center plate
 - ↗ Full 20m length; no connections
 - ↗ Strip polarity opposite for tubes on either side of the center plate
 - ↗ Bipolar, differential electronics
 - ↗ Same electronics for tubes
- X-strips
 - ↗ Foil with strips glued on tubes
 - ↗ Wire/x-strip readout differentially
 - ↗ Readout from each side, or coupled for 20 m readout
- Unit size and weight
 - ↗ Laminated unit is 10 m x 20 m
 - ↗ Unit mass is ~10T

Use absorber as the building core

- Transverse truss to support walls and roof



- Longitudinal truss cantilever over the assembly area
- New absorber sections rotated into place
- Temporary walls move back as absorber is assembled



Conclusions

- Particleboard absorber requires no containers, can be drilled, sawed, screwed, glued, etc., and is less expensive than any other choice (including water). Also, it may simplify the building and reduce its costs
- Alternating spacer/detector design allows monolithic structure with essentially no dead regions. Also applicable to scintillator, or RPC based detector.
- Hodoscopic tolerances allow cost effective gas tube construction techniques.
- 2D readout concept looks practical.
- R&D issues:
 - ↗ Select extrusion materials and dimensions
 - ↗ Verify strip readout scheme and cost benefits
 - ↗ Prototype endplates and wire supports
 - ↗ Investigate semi-automatic wiring
 - ↗ Prototype robot if necessary